Space Weather Technical Forecast

Issued on Sunday, 09 July 2023 at 13:07 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of fluence increasing to Active (1e8 integrated pfu). Chance of R1/R2 radio blackouts throughout. Chance of G1/Minor storms Day 4 (12 July).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with only isolated C-class flares observed in the past 24 hours. There are currently 10 sunspot regions on the visible disc, with a new region developing west of AR3359. AR3361 remains the most magnetically complex region, with two small delta spots visible within the trailing region. AR3363 is the largest region on the disc, which mostly consists of a very large spot, with a weak trailer spot just about visible. AR3366 has shown little change in recent hours, whilst newly numbered AR3367 continues to grow. The other regions appear mostly small and simple at this stage. No Earth-directed CMEs have been observed in available imagery during the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1, showed a gradual declining trend through the last 24 hours. Wind speeds were slightly elevated, peaking at around 440km/s, gradually declining to slow-ambient levels, near 350km/s. The density was mostly below average. Total magnetic field strength has been weak throughout at 7 nT or below, with the north-south component also varying weakly. The phi angle has been mostly positive (away from the Sun), but with some negative (towards the Sun) variations. Geomagnetic activity has been Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, was at background to moderate levels, with a peak of 830 pfu at 08/1735 UTC. The 24-hour integrated fluence was below the Active (1e8 integrated pfu) threshold but rose slightly. A fluence of 3.09e7 pfu was recorded at 09/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: A continuation of Low activity is most likely, but with a chance of M-class flares.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs are currently expected. The solar wind speed is expected to be near ambient, or perhaps slightly elevated, levels through much of this period. A High Speed Stream (HSS) from CH23/- is likely to arrive either on Day 4 (12 July), or just after the end of this period.

Geomagnetic activity is forecast to be mostly Quiet to Unsettled, but with an increasing risk of G1/Minor storms during Day 4 and a slight chance of an isolated G2/Moderate storm interval.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight chance of reaching the S1/Minor Storm threshold through the period, should any larger flares occur. High energy electron flux (greater than 2MeV) may just peak diurnally at high

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levels, perhaps with a sharper decline on Day 4 (12 July). Electron fluence may rise a little at first, with a chance of reaching Active (1e8 integrated pfu), before likely declining on Day 4.

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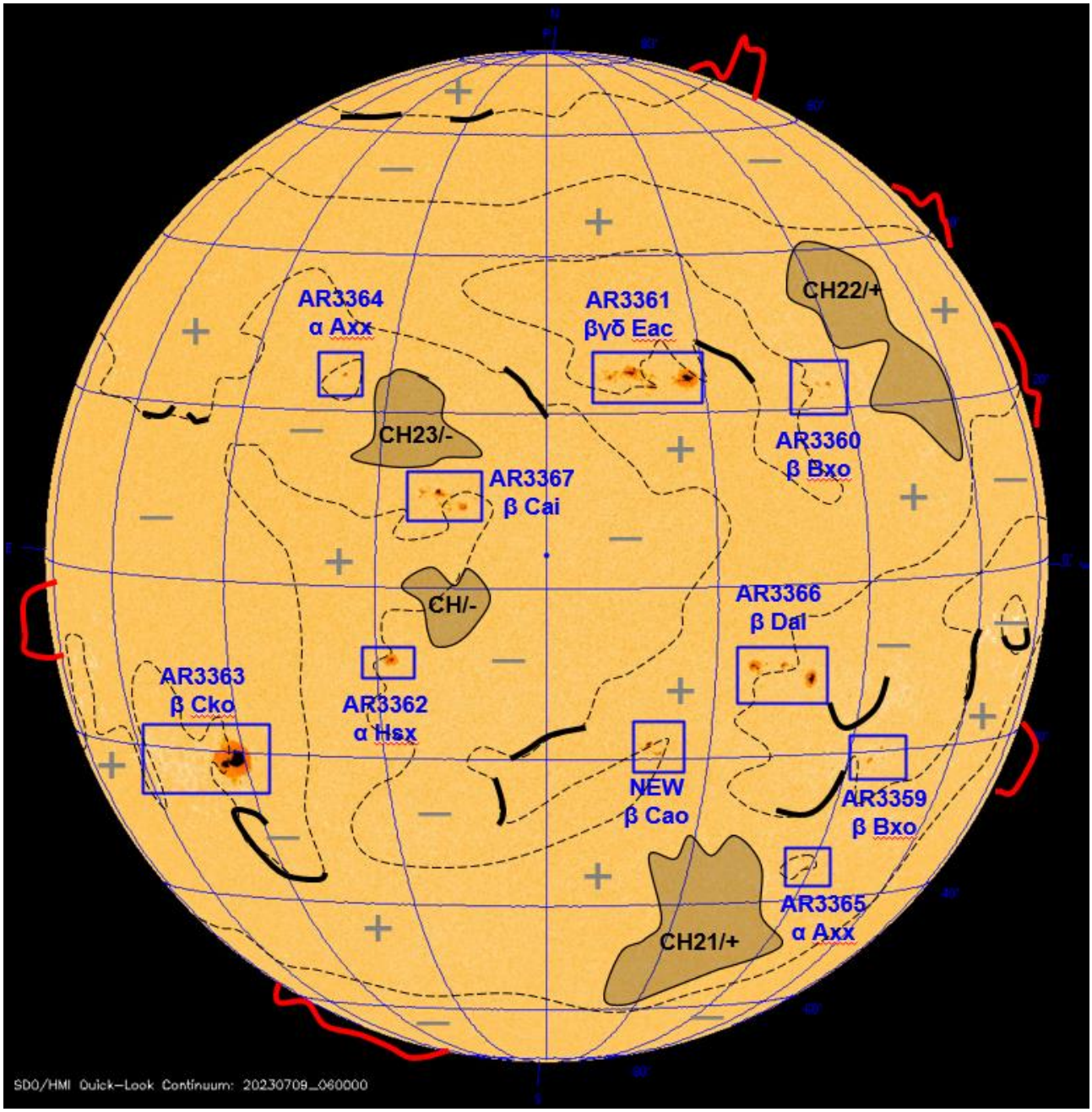
Figure 1. Solar Analysis Valid 09/0600 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth directed CMEs are currently expected. The solar wind speed is expected to be near ambient, or perhaps slightly elevated, levels through much of this period. A HSS from CH23/- is likely to arrive either on Day 4 (12 July), or just after the end of this period. On the previous rotation this feature gave wind speeds of 600-700 km/s, and a maximum geomagnetic impact of a G2/Moderate storm. It does look a little more fragmented this time around however, so wind speeds and impacts may be a little lower, but there is a risk of similar effects occurring on this rotation.

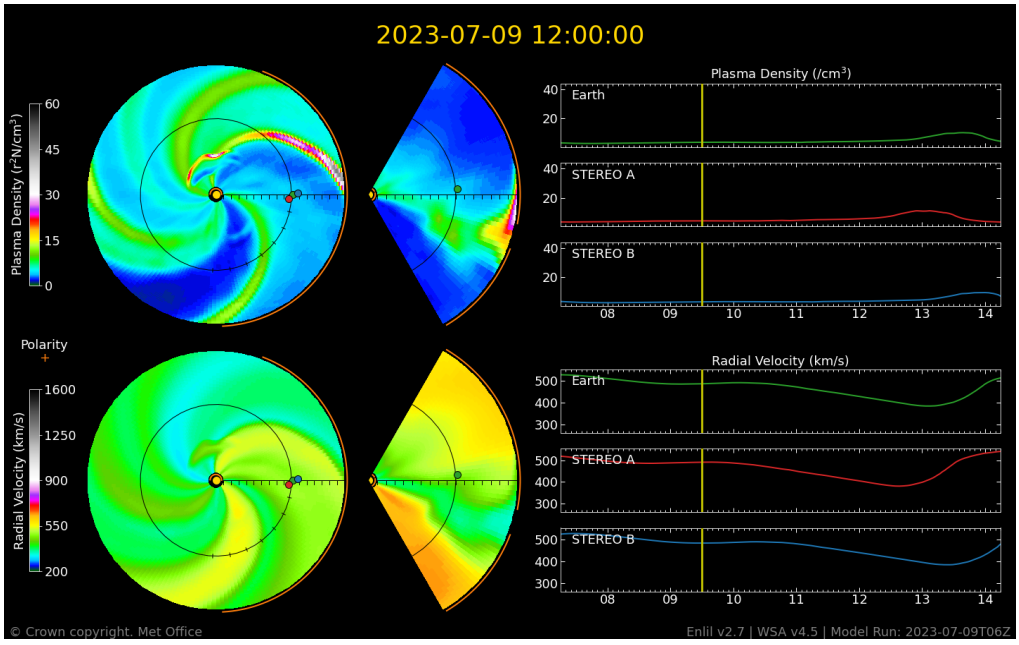
Geomagnetic activity is forecast to be mostly Quiet to Unsettled, but with an increasing risk of G1/Minor storms during Day 4 and a slight chance of an isolated G2/Moderate storm interval.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMES are currently expected**.**

Figure 2: MOSWOC Enlil currently has wind speeds around 150km/s too fast. Wind speeds are currently at slow-ambient levels, well below Enlil's expectations. The next HSS is expected either on Day 4 (12 July) or just beyond this forecast period.



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Radio Blackouts - X-Ray Flares:
Solar activity has been Low over the past 24 hours, with only isolated C-class flares observed. There are currently 10 sunspot regions on the visible disc, with a new region developing east of AR3359 (Bxo/Beta). AR3361 (Eac/Beta-Gamma-Delta) remains the most magnetically complex region, with two small delta spots visible within the trailing region. AR3363 (Cko/Beta) is the largest region on the disc, which mostly consists of a very large spot, with a weak trailer spot just about visible. AR3366 (Dai/Beta) has shown little change in recent hours, whilst newly numbered AR3367 (Cai/Beta) continues to grow, which is now classified as a Cai/beta configuration. The other regions appear mostly small and simple at this stage.

A continuation of Low activity is most likely, but with a chance of M-class flares. No major active region is forecast to depart the visible disc during the period and far side sounding data suggests that further regions may rotate onto the disc during the coming days. These regions cannot be assessed until they become visible however, and with no obvious activity from over the limb, therefore the flare probability has been kept flat through this period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES X-Ray flares

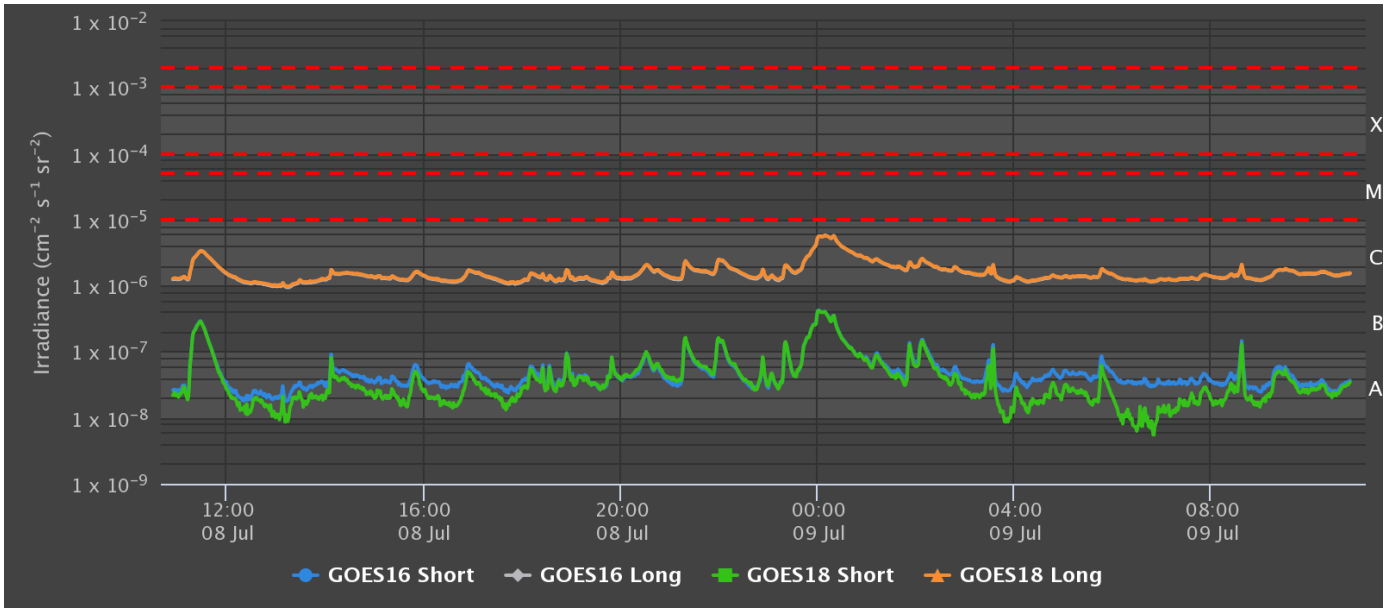

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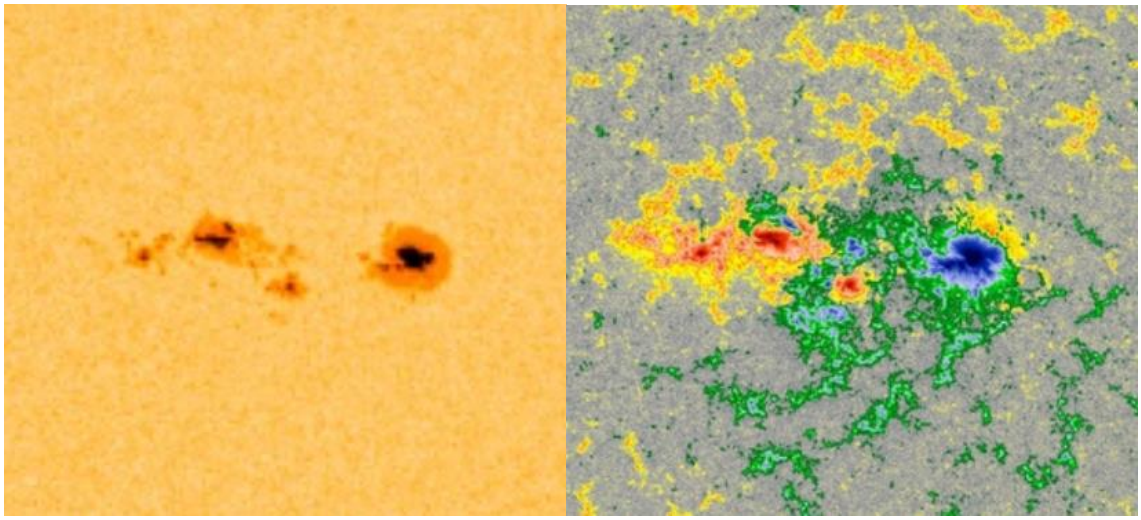
Figure 4: SDO intensitygram and magnetogram shows AR3361 near the north-centre disc, with two small delta spots in its trailing portion



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. There is a very slight chance of S1/Minor storm levels being reached through this period, should any larger flares occur mainly from regions in the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been peaking over the last few days at moderate levels. The BAS radiation belt model suggests some very limited increase in electron flux has taken place below GEO, likely due to the recent HSS. As such, electron flux may just reach high levels at the diurnal maxima in the coming days. With limited geomagnetic activity expected until the arrival of a further HSS on Day 4 (12 July), this is likely to continue through much of the period before a probable sharper decline once the HSS sets in.

Electron fluence has been rising slightly but is still below Active levels (1e8 integrated pfu). A continued slight rising trend is possible, with a chance of reaching Active in the coming days, before a decline from Day 4. MOSWOC REFM is showing a steady trend below Active, which may be reasonable, as confidence in the peak fluence level likely to be reached is currently low.

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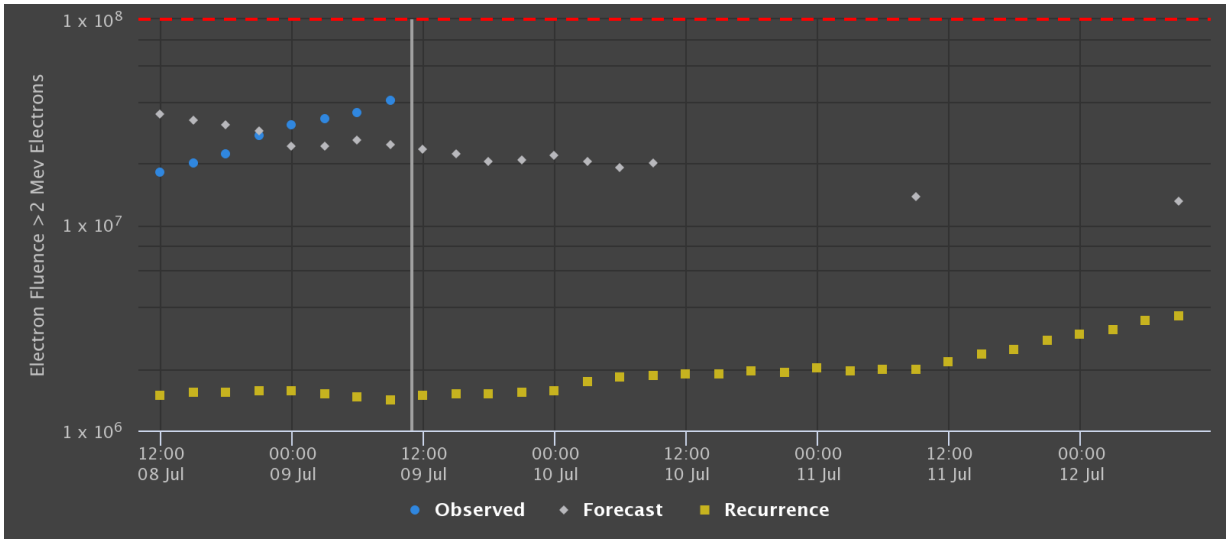
GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	40	40	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM electron fluence – observations, forecast and recurrence.



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